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Appn. Number 10/644,393 (Lundstrom, et al.) GAU2858 Amnt. A - 1 -

In the United States Patent and Trademark Office

Appn. Number: 10/644,393

Appn. Filed: 08/18/2003

Applicant(s): John W. Lundstrom
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Appn. Title: Electrically Measuring Soil Density and Moisture Content

Examiner/GAU: Marina Kramskaya/2858

Mailed: 02/06/2004
At: Carson City, NV

Amendment A

Assistant Commissioner for Patents

Washington, District of Columbia 20231

Sir;

In response to the Office Letter Mailed October 14, 2004, please amend the above application as follows:

Title: Change to: Electrically Measuring Soil Dry Density

Information Disclosure Statement:

Page 2, Change title: "Cross References Related to Patent Documentation", to read "Related Patent Documentation".

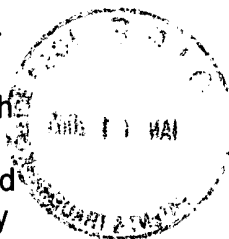
Add after last Para.: "See attached form PTO-1449 for additional prior art."

Specification:

Delete Abstract of record (two paragraphs), and substitute attached **ABSTRACT**.

Page 2, Field of the Invention, line 1, delete: "and moisture content".

Page 2, Field of the Invention, line 3, delete: "and moisture content".



Page 4, Background of the Invention, Cont'd., delete last Para. and replace with:
One such micro-wave device is described as a density and moisture content measuring invention. (U.S. Patents 5,801,537, 5,933,015, and 6,215,317 – “Method and apparatus for measuring in-place soil density and moisture content”, all to Siddiqui, et al.). The specifications describe how the volumetric moisture content can be estimated from measurement of the dielectric constant of a test sample of soil. It also infers that gravimetric density can be estimated from the same measurement of dielectric constant, by reference to another laboratory measurement. It is questionable that specific gravity can be measured using dielectric constant only, since in practice, two samples of soil can be prepared that have exactly the same dielectric constant, but have different gravimetric densities and gravimetric moisture contents.

Laboratory testing during the invention of EDG showed that a much higher correlation to the unit weight of water in a soil sample can be achieved using the **quotient of measured volume capacitance and measured volume resistance**, which is a new and novel feature of the EDG invention.

Page 4, Summary of the Invention, Para.1, line 1, after “portable” add: “non-nuclear”.

Page 4, Summary of the Invention, Para.1, line 2, delete: “moisture content”.

Page 4, Summary of the Invention, Para.1, line 2, add: “construction materials and/or” after “dry density in” and before “soils”.

Page 5, Summary of the Invention, Cont'd., in the Para. starting with “The Electrical –”, line 3, delete: “moisture content”.

Page 6, Summary of the Invention, Cont'd., line 1, add: “geotechnical” before “sand cone” and put “sand cone” in parenthesis.

Page 6, Summary of the Invention, Cont'd., in the Para. starting with “After calibration-”, line 4, delete: “estimated”.

Page 6, Summary of the Invention, Cont'd., in the Para. starting with “After calibration-”, line 5, delete: “and soil moisture content”.

Page 6, Summary of the Invention, Cont'd., in the Para. starting with “The EDG uses-”, line 5, delete: “correct them to provide representations of” and replace with: “computes”.

Page 6, Summary of the Invention, Cont'd., in the Para. starting with “The EDG uses-”, line 9, delete: “functions” and replace with: “resources”.

Page 6, Summary of the Invention, Cont'd., in the last Para., line 1, add as the first words: “From the electrical soil measurements, ”.

Page 6, Summary of the Invention, Cont'd., in the Para. that now begins with “From the electrical-”, line 4, delete: “an estimate of”.

Page 7, Summary of the invention, Cont'd., line 1, delete: “an estimate of”.

Page 7, Summary of the Invention, Cont'd., line 2, delete: “estimated”, and replace with: “measured”.

Page 7, Summary of the Invention, Cont'd., line 2, delete: “estimates of”.

Page 7, Summary of the Invention, Cont'd., line 3, delete: “and moisture content”.

Page 7, Summary of the Invention, Cont'd., line 3, delete: "estimates", and replace with: "values".

Page 7, Summary of the Invention, Cont'd., in the Para. that begins with "The soils engineers-", line 2, delete: "estimated" and replace with: "measured".

Claims:

Cancel all claims of record and substitute new claims as follows:

What is claimed is:

1. An Electrical Density Gauge consisting of electrode means for electrically connecting to an in-situ test spot of compacted construction material (soil), electrical means for measuring the equivalent parallel resistance and equivalent parallel capacitance of said material, and means for performing the necessary computations and display of results,

is calibrated by first measuring a plurality of in-situ test spots in a field of said construction material to determine values of said equivalent resistance and capacitance, then determining with the use of geotechnical means, the in-situ wet density and in-situ weight of water of the same plurality of test spots where electrical measurements were made,

and with the use of said electronic computational means, the real impedance of the measured test samples is determined, the best fit regression equation between the physical wet density data points and real impedance data points is calculated,

and also with the use of said electronic computational means, the ratio of measured capacitance and measured resistance is determined for all data points, then the best fit regression equation between the unit weight of water data points and capacitance / resistance ratio data points is calculated,

said Electrical Density Gauge after being thus calibrated, is used to measure field test spots of the same type of construction material with previously unknown electrical characteristics and with the newly determined values of real impedance and capacitance / resistance ratio applied to the aforementioned regression equations, to compute a value of wet density and a value of unit weight of water for said unknown test spot,

and using the aforementioned electronic computational means, the dry density of the constructional material at the unknown test spot is calculated from the wet density and unit weight of water.

2. The Electrical Density Gauge of Claim 1, wherein the value of maximum dry density of the tested constructional material as determined by geotechnical means is entered into the aforementioned computational means, and used with the newly determined value of dry density to compute the percent of maximum compaction of the constructional material at each field test spot.

ABSTRACT

The object of the Electrical Density Gauge (EDG) invention is to provide a low cost, portable, non-nuclear, and rugged field-use device that measures dry density in soils that have been constructed for use as road-beds and building foundations. This data is used to ensure the quality control of the constructed foundation. The electrical properties of soil are measured at a radio frequency using probes driven into the soil. To calibrate EDG, certain algorithms of these electrical properties are related to physically measured wet densities and unit weights of water for a plurality of calibration test spots. Correlation regressions are found, that are used to convert values of the electrical properties measured at unknown field test spots into values of dry density.

REMARKS – General

By the above amendment, Applicants have amended the title to emphasize that the primary purpose of the invention is to measure dry density of soils.

The applicants have removed all mention of the measurement of moisture content of soil as being a function of this invention.

The applicants have also re-written the claims to better define the invention related to prior art, as well as to overcome the technical rejections.

The applicants have re-written the Abstract so it is one paragraph, and better explains the operation of the invention.

The Rejection of Claim 1 on Christy is Overcome

The applicants agree with the Examiner as relates to the wealth of prior art in the field of moisture measurement, and have re-written the scope of the invention and claims to exclude the function of moisture measurement. The applicants respectfully disagree with Examiner related to Christy teaching moisture measurement. In fact, Christy teaches the measurement of soil conductivity as relates to soil grain size for agricultural purposes. It is not likely that Christy would turn up in a search of prior art related to measurement of dry density of soil.

The Rejection of Claim 1 on Pullman is Overcome

Pullman teaches moisture measurement only in tobacco, by use of the in-phase component of current passing through the test sample, thus producing the real resistance of the sample. Although his drawings show a parallel resistance and capacitance, he makes no claim for any determination of the value of the parallel capacitance. Applicants have tested a wide variety of soils, and found that the large variation of salt content and grain sizes make a simple resistance measurement inadequate for proper determination of soil dry density. It is not likely that Pullman would turn up in a search of prior art related to measurement of dry density of soil, and thus, the connection of Christy and Pullman would not have been likely to the applicants.

The Rejection of Claim 1 on Campbell is Overcome

Campbell relates only to moisture measurement of soil, and not soil dry density. It is not likely that Campbell would turn up in a search of prior art related to measurement of dry density of soil, and thus, the connection of Christy and Campbell would not have been likely to the applicants.

There is no justification, in Christy or Pullman or Campbell, or in any other prior art separate from the applicant's disclosure, which suggests that these references be combined, much less be combined in the manner proposed.

With regard to the proposed combination of Christy, Pullman, and/or Campbell, it is well known that in order for any prior-art references themselves to be validly combined for use in a prior-art § 103 rejection, *the references themselves* (or some other prior art) **must** suggest that they be combined. E.G., as was stated in In re Sernaker, 217 U.S.P.Q. 1, 6 (C.S.F.C. 1983):

"[P]rior art references in combination do not make an invention obvious unless something in the prior art references would suggest the advantage to be derived from combining their teachings."

Comments on Other Prior Art

With regard to the citation of prior art by Anderson, et al., US 6,380,745, Konig, et al., US 3,769,581, and Matlin, US 3,882,383, none of these inventions teach the measurement of soil capacitance (dielectric constant) to be used for the determination of either soil moisture content or soil density. When researching the EDG principles, the applicants found that for accurate determination of dry density, it is necessary to determine both the equivalent parallel soil resistance and equivalent parallel soil capacitance, and combine and correlate these in the new and novel methods described in this application.

New and Novel Features of the Invention

The Examiner is respectfully reminded that prior art does not teach the use of the two correlating factors that make this invention new and novel. First, the quotient of measured soil capacitance and measured soil resistance is correlated with the physical unit weight of water of the soil, and second; the real impedance of the soil is correlated with the physical wet density of the soil. These novel correlation factors produce new and unexpected results, and hence are unobvious and patentable over these references and other references that employ simple capacitance or resistance only to measure soil properties.

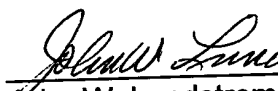
Conclusion

For all the above reasons, applicants submit that the specification and claims are now in proper form, and that the claims all define patentably over the prior art. Therefore they submit that this application is now in condition for allowance, which action they respectfully solicit.

Conditional Request for Constructive Assistance

Applicants have amended the specification and claims of this application so they are proper, definite, and define novel structure which is also unobvious. If, for any reason, this application is not believed to be in full condition for allowance, applicants respectfully request the constructive assistance and suggestions of the Examiner pursuant to M.P.E.P. § 706.03(d) and § 707.07 (j) in order that the undersigned can place this application in allowable condition as soon as possible and without the need for further proceedings.

Very respectfully,


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Dave Straley


William Ehni


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-----Applicants Pro Se-----

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ABSTRACT

The object of the Electrical Density Gauge (EDG) invention is to provide a low cost, portable, non-nuclear, and rugged field-use device that measures dry density in soils that have been constructed for use as road-beds and building foundations. This data is used to ensure the quality control of the constructed foundation. The electrical properties of soil are measured at a radio frequency using probes driven into the soil. To calibrate EDG, certain algorithms of these electrical properties are related to physically measured wet densities and unit weights of water for a plurality of calibration test spots. Correlation regressions are found, that are used to convert values of the electrical properties measured at unknown field test spots into values of dry density.

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